

MONTHLY WEATHER REVIEW

HERBERT H. KIMBALL, Acting Editor.
CHARLES F. BROOKS, Associate Editor.

VOL. 47, No. 3.
W. B. No. 680.

MARCH, 1919.

CLOSED MAY 3, 1919.
ISSUED JUNE 10, 1919.

CONTRIBUTIONS AND BIBLIOGRAPHY.

CONVECTIONAL CLOUDS INDUCED BY FOREST FIRES.

By FORD ASHMAN CARPENTER, Meteorologist.

[Dated: Weather Bureau, Los Angeles, Calif., Apr. 12, 1918.]

The spectacle of a cloud-crowned smoke column is not an unusual sight in southern California. Notwithstanding alert forest protection, fires in the timber or chaparral are not uncommon during the long rainless summers of this region. The heat during such fires is intense and concentrated owing to the conflagration being limited to a relatively small area. They, therefore, induce strong vertical convection.

During the past five years five examples of local convection resulting from forest fires in southern California have come under the writer's notice. They have many attributes in common, and yet they possess considerable individuality as the photographs of three of them which accompany this article show.

Example No. 1.—This cloud has already been described in the REVIEW as follows:¹

On August 23, at 3:48 p. m., a brush fire in the northern foothills sent up a straight column of smoke. When the fire reached its maximum intensity a small but well-developed cumulus cloud was seen to cap the ascending column. When the smoke column disappeared the cloud lasted two or three minutes. It was an interesting instance of cumulus cloud formed by ascending currents. The sky was free from cloud all day except for this solitary cumulus, which had an existence of less than five minutes.

Example No. 2.—One of the fiercest forest fires in this district, but one which covered a relatively small area, occurred on the morning of September 13, 1913. This fire destroyed the forest cover of Sister Elsie Peak (15 miles north of Los Angeles). In the case of this fire the writer was so near it as to be able to note many of its features. The notes made at the time state that a smoke column was observed ascending over the northwestern horizon. This pillar of smoke mounted steadily to a great altitude, and in a short time was capped by a well-defined cumulus cloud (see fig. 1). Up to the hour of the appearance of the smoke column, the sky was free from clouds, the day being unusually hot, the thermometer registering 90° F. as early as 8:30 a. m., and remaining above 90° until 2 p. m. About 10 a. m. the fire-caused cloud mushroomed, and within an hour the western portion of the sky became filled with cumuli extending in uniform thickness to the seacoast beyond. The photograph of the smoke and cloud above Sister Elsie Peak (elevation 5,080 feet above sea level) was made from Echo Mountain, which has an elevation of 3,500 feet above sea level. The very rapid changes in the structure of the column made a focal-plane exposure necessary. The exposure was about 0.001 second at 10 a. m. The most striking feature of the cloud was the well-defined mantle (scarf

cloud²) which formed after the cloud mushroomed. This marked the dividing line between the smoke and the ensuing cloudy condensation.

Example No. 3.—Not all forest-fire clouds last as long as the one on Sister Elsie Peak; more frequently they have a very short existence, as, for example, the cumulus cloud which made its appearance in the eastern portion of southern California on August 5, 1915. A member of the Forest Service, on duty in that locality, thus describes it:³

During a brush fire August 5, 1915, a cumulus cloud developed at the head of a smoke cloud which appeared at 3:05 p. m. and lasted 20 minutes. It reappeared at 4:55 p. m. and lasted 12 minutes. The cloud was a typical cumulus and formed close to 1,000 feet above the fire area.

Example No. 4.—Another well-developed cumulus cloud was formed during the forest fire of September 3, 1917. This with a scarf cloud at its apex is shown in figure 2. The secondary (scarf) cloud disappeared within 30 minutes, as it is not shown in a photograph made about half an hour after the first picture. This second picture (fig. 3) shows the maximum mushroom phase. Further observation of the progress of the terminating cloud showed that it did not spread out as in previous instances of like formation.

The appearance of this cloud, and its phases, were described by Mr. T. R. Woodbridge, in a letter to the writer, dated Upland, Cal., September 29, 1917, as follows:

I am sending you a photograph that only partially illustrates a very beautiful phenomenon we had near us * * * (Sept. 3, 1917) during a forest fire east of Cucamonga Canyon. It was a breathless day and even the almost sure sea breeze failed to show up until after 3 o'clock, so the black smoke of the fire went up in the air without a bend in any direction. About noon I saw foaming out from the top of the black smoke a cottony mass of purest white. This appeared first from the center of the black part and boiled from the center outward, gradually spreading toward the outside edges of the black part. The line of demarcation was very sharp and was not broken till about 3:30 p. m. when the sea breeze came up. I was downtown and made a swift run to my home to get my camera into action, but in the short time that this took the appearance had changed to that shown by the photograph [see fig. 2]. It was a magnificently beautiful sight, and the whole community for miles around admired it. You can see the line clearly in the photograph, but the black is much lighter-appearing than it actually was. I regret that I have not a photograph taken earlier, as the black smoke had as regular a pattern as a tall vase, and the pure white cloud was something like a mass of white dahlias or chrysanthemums adorning it.

This description was supplemented by the two photographs (figs. 2 and 3), also a memorandum of tempera-

¹ MONTHLY WEATHER REVIEW, 1912, 40: 1258.

² See MONTHLY WEATHER REVIEW, 1917, 45: 361-363.

³ E. W. MUMMS, MONTHLY WEATHER REVIEW, 1915, 43: 445.



FIG. 1.—Smoke column producing cloudy condensation over Sister Elsie Peak. (Photograph made from Echo Mountain, 10 miles east of Sister Elsie Peak. The other cumuli, shown in the photograph, did not appear until after the cloud mantle formed.) [Photographed by O. H. Lawrence.]

ture and relative humidity data from privately owned instruments located within a few miles of the fire. From these record sheets a temperature of 84° F. and a dew point of 49° F. were deduced.

Example No. 5.—On December 31, 1917, another observation of cloud formation by a forest fire was made. In a photograph (fig. 4) made from the cooperative storm-warning display station of the Bureau on the shores of Santa Monica Bay, may be seen a cloud from a forest fire originating in the near-by Malibu Canyon. The tall column of smoke was carried horizontally northwestward under the influence of the light off-shore breeze. At an altitude of about 5,000 feet, condensation occurred over the upper surfaces of the smoke.

NOTE.

Some 20 years ago while I was stationed in Minneapolis a large lumber mill was destroyed by fire. The heat was intense and at an altitude of about 1,000 or 1,500 feet, I should judge, a cumulus cloud formed almost directly over the center of the fire. As I recollect, the general movement of the wind on that day was very slight, but the surface winds were quite fresh, blowing in toward the fire on all sides. This I know, because I went completely around the fire for the purpose of ascertaining if such was the case. . . .

The movement of the surface winds on all sides of the fire, in my opinion, is an important factor to be considered, especially in the case of very large fires such as have occurred in the North Pacific States, as well as in Minnesota, Michigan, and Canada. In looking over a Signal Service publication on the forest fires in Michigan, published many years ago, it was noted that the wind force close to the fire was reported to be very strong,¹ whereas the barometric gradients at that time indicated only light winds. I sometimes think that the winds engendered by fires of this character have a tendency to increase the area burned over, as well as the intensity of the fire, by thus supplying abundant oxygen to the burning pile. Of course, if the winds blew inward with equal force on all sides this would not occur, as after the inflammable materials were all consumed that would end the combustion; but if the pressure were greater on one side than on another, then the mass would progress and continue burning furiously so long as there was anything to burn.—*E. A. Beals, Section Director.*²

NOTES ON A CUMULUS CLOUD FORMED OVER A FIRE.

C. A. REICHEL, Assistant Observer.

[Dated: Weather Bureau, Honolulu, Hawaii, Dec. 10, 1918.]

An interesting form of the various cumulus clouds which occur almost daily in Hawaii is the small clouds that occasionally appear over the fires of the burning sugar-cane fields. These clouds have been seen near Honolulu several times and close observations were made of a typical specimen on September 27, 1918.

This cloud was observed from a train which passed around the fire and was about 2 miles distant from it. Observations and photographs were made at the stations where the train stopped and the time determined from

the train schedule. The fire forming the cloud was from a cane field consisting of 35 acres and located on a narrow peninsula in Pearl Harbor, Oahu, and was about midway between the United States Weather Bureau at Honolulu and the United States Magnetic Observatory at Sisal, Oahu, and about 8 miles distant from each.

The fire began at 4:40 p. m. and a large column of smoke was immediately formed with a slight flattening at the top at a height of about 700 feet. As the fire made headway the smoke became more dense and kept rising and spreading out. The first roll of cumulus developed at the top of the column in about 10 minutes, and was well-marked by its white color, which contrasted strongly with the bronze black of the smoke. The cumulus rolls continued to form swiftly and at 4:57 p. m. (see fig. 1) when the fire was at its height the cloud had almost reached its final size, although the smoke, which was still very heavy, obscured it considerably. As the fire diminished the column of smoke from the earth gradually became less (see fig. 2), but the cloud continued to rise for a short distance, the base clearing somewhat and small rolls still forming at the apex. At 5:03 p. m., when the fire was practically out, the column of smoke from the earth had almost disappeared and a well-formed cumulus cloud was present. It was last seen at 5:15 p. m., or 20 minutes after it began to form, when the train passed out of the field of view.

An estimate of the height of the cloud and also of its size was formed by taking the altitude of the sun, which was observed through the edge of the cloud, and the horizontal distance of the base from the observer. At two different stations approximately the same results were obtained, which gave for the height of the base of the cloud about 1,500 feet and for the top about 2,500 feet, and for the width at the base about 1,000 feet. A comparison with the height of the 600-foot wireless aerial at the Pearl Harbor Naval Station gave a good check on these figures.

The approximate meteorological conditions under which the cloud was formed can be obtained from an average of the records of the United States Weather Bureau and the United States Magnetic Observatory, both of which are official records. The temperature at the Weather Bureau Office, 8 miles to the east, at 4:30 p. m., or just preceding the fire, was 79°; at the Magnetic Observatory, 8 miles to the west, it was 84°, giving a mean temperature of 82°. The dew point and the relative humidity at both stations were the same, being 68 and 71 per cent, respectively. The direction of the wind was from the south, with a velocity of 8 miles per hour at Honolulu.*

As previously mentioned, these clouds have been observed frequently at Honolulu and they have been seen at all seasons of the year. They are usually formed in the early morning or late afternoon hours and have never been observed forming in the middle of the day. They are best formed under conditions of calm or very light winds, occur over fires of all sizes, and have been known to form over large smokestacks on very still days. They are apparently true cumulus and have the same color, shape, and appearance as other cumulus clouds in Hawaii. Also they do not dissipate rapidly as would be the case with smoke clouds. In the present instance the cloud was only seen for a relatively short time, but in June, 1917, a cloud of much greater size, formed at 8 a. m., was still visible two hours later. No instances have ever been recorded in these islands of these clouds producing precipitation.

¹ The same was decidedly the case in the Minnesota fires of mid-October, 1918, as mentioned in the MONTHLY WEATHER REVIEW, November, 1918, 46: 506-509, and as described in detail by H. W. Richardson in the Geographical Review, April, 1919, 7: 220-232, 5 figs.—EDITOR.

² See also "Meteorological observations during the burning of the plant of the Standard Oil Company at Bayonne, N. J., July 6, 6, and 7, 1900," by W. H. Mitchell (Mo. Wea. Rev., 1900, 28: 325-326).—EDITOR.